Uranium and thorium records in the Holocene high-resolution sediments from Borsog Bay in Lake Hovsgol, Mongolia

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Climatic changes occurring in central Asia have been recorded in lacustrine sediments as variations of indices such as diatoms, pollen particles, water content and chemical fossils (Fedtov et al., 2004; Prokopenko et al., 2005, 2007). Among these indices, trace element, uranium (U) has also been noted as one of the most important chemical fossils (Edgington et al., 1996; Goldberg 2008).

Lake Hovsgol (elevation 1645 m), the largest lake in Mongolia, is located in the Baikal Rift Zone on the southern fringes of the East Siberian permafrost zone and it is connected to Lake Baikal through the Egiin River, a tributary of the Selenga River. These features promise a sensitive response to regional environmental changes in East Asia. It is, therefore, of great interest to study sedimentary U and Th and their sedimentation behaviors in Lake Hovsgol, considering the unique aqueous chemical conditions such as high salinity and alkalinity, and past changes in lake-level and other factors.

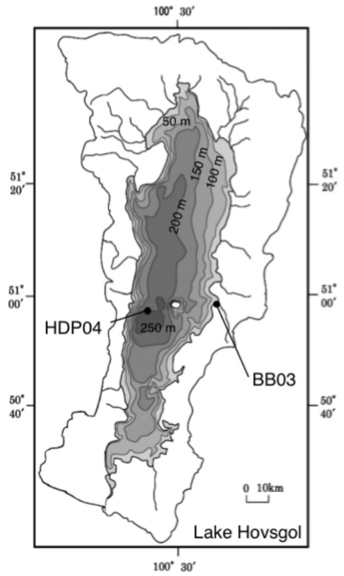

Fig.1 Map of Lake Hovsgol showing coring sites BB03.

In this study, an attempt was made to understand the U depositional behavior as a link to the further possibility of U serving as a climatic indicator. A sediment core (BB03) was obtained from Borsog Bay on the eastern shore of Lake Hovsgol. By taking into account the BB04 core (7.2 m length, already dated by ^{14}C) which was previously taken near where core BB03 was obtained, the BB03 core is expected to retain records for about the past 10 kyr, during the Holocene period, and to be characterized as a core having a high sedimentation rate (ca. 0.1 cm/y). The concentrations of U and Th isotopes (^{238}U, ^{234}U, ^{230}Th, ^{232}Th) and some major elements (Fe, Al, Ti, etc.) in the sediment core BB03 were measured along with ^{14}C dating, sediment composition (organic, carbonate and biogenic silica contents, etc.) and grain sizes of whole sediment particle and mineral.

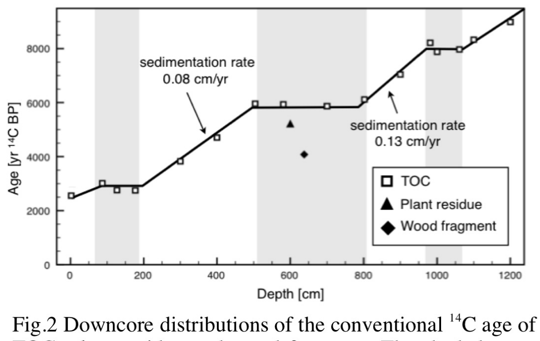

Fig.2 Downcore distributions of the conventional ^{14}C age of TOC, plant residue and wood fragment. The shaded areas indicate a layer with sedimentation rate anomalies.

The ^{14}C age for TOC was 2.5 kyr BP at the surface layer, and 9.0 kyr BP at the lowermost layer. Small age differences observed at depth ranges of 87-177, 504-802 and 981-1061 suggested the occurrence of some climatic events that increased the sedimentation rate. These events were tentatively estimated to be 0.3-0.8, 3.5-4.0 and 5.5-6.0 kyr ^{14}C BP by subtracting 2.0-2.5 kyr as the regional reservoir effect from ^{14}C ages for TOC. The ^{234}U/^{238}U and ^{230}Th/^{238}U ratios during event periods showed a trend to move closer to equilibrium, indicating that a large amount of terrestrial matter deposited rapidly.

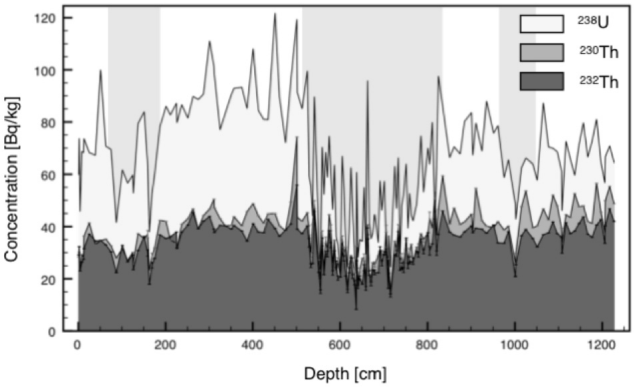

Fig.3 The depth profiles of ^{238}U, ^{230}Th and ^{232}Th in bulk sediments.

The discrepancy of the depth distributions between ^{232}Th and Ti or Al suggested the existence of authigenic ^{232}Th in sediments. The authigenic ^{232}Th fraction estimated by using Ti as the correction index for terrigenous component was up to 80% of the bulk concentration. The existence of authigenic ^{230}Th would have a serious effect on U-Th dating for lacustrine sediments.

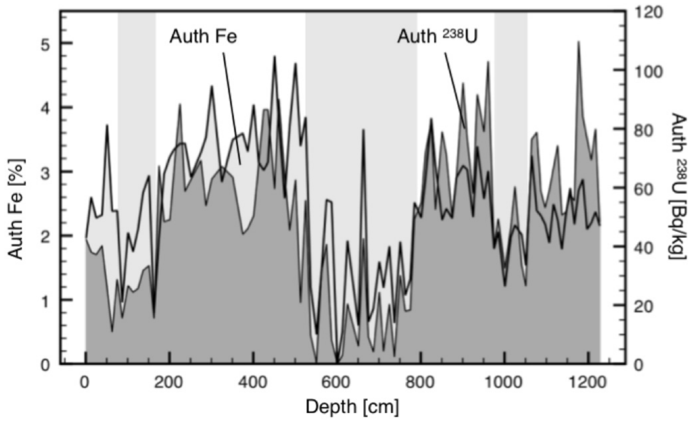

Fig.4 Comparison of authigenic Fe and authigenic ^{238}U.

The downcore distribution of authigenic U estimated by using Ti correlated well with that of bulk U in sediments. The apparent distribution coefficient ($^{U}Kd^{Fe}_{0}$) between dissolved U and authigenic Fe at present was estimated to be $10^{5.5}$ (log ($^{U}Kd^{Fe}_{0}$) = 5.5), suggesting that the coprecipitation with iron oxy-hydroxides was the main cause of authigenic U.

The U concentration in bulk sediments was more likely to be controlled by dissolved U, the amount of precipitated iron oxy-hydroxides and $^{U}Kd^{Fe}$. If the $^{U}Kd^{Fe}$ values have been constant, the U concentration of bulk sediments could reflect the intensity of chemical weathering of terrestrial rock. However, considering the instability and variation of $^{U}Kd^{Fe}$ under the conditions of Lake Hovsgol, further interpretation of the variation of U in sediments will be needed.

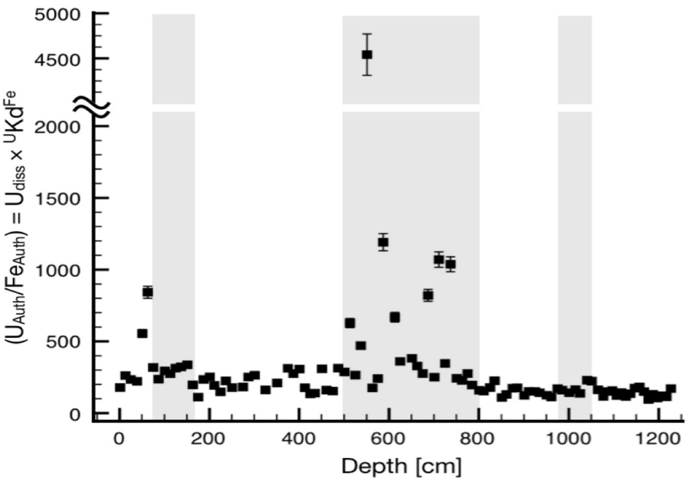

Fig.5 Product of $^{U}Kd^{Fe}$ and U_{diss} calculated from authigenic Fe and U.